VII. *Remarks on the Examination of some Fossil Woods, which tend to elucidate the Structure of certain Tissues in the recent Plant.* *By* EDWIN JOHN QUEKETT, *Esq., F.L.S. &c.*

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AMONG the many disputed points in vegetable anatomy, few have excited more controversy than the structure of spiral vessels, and the markings on the woody fibres of plants belonging to the order *Coniferæ*. Having found instances of these structures in the fossil state which appear satisfactorily to explain their nature, the following observations are offered to the notice of the Society. In doing so, it is not intended to enter into any detailed account of the minute anatomy of these parts, as it is generally known and already described in most botanical works.

From the period of the discovery of spiral vessels in plants by Henshaw, in 1661, up to the last quarter of a century, numerous have been the theories respecting their structure; the older vegetable anatomists, from the imperfection of their microscopes, were led to form various opinions on these minute organs, which have been recorded in works on vegetable anatomy. The true structure, by the aid of delicate manipulation and improved means of observation, had however, to most recent observers, appeared to be determined; as it can be shown that these organs are composed of a cylinder of membrane closed at each end, in the interior of which are one or more fibres coiled spirally. This is a fact often to be seen in favourable dissections, and is decidedly manifest when the development of the fibre is watched in the manner I have described in vol. i. of the 'Transactions of the Microscopical Society;' but another opinion has been entertained, that the fibres are coiled spirally on the exterior of the cylinder of membrane, instead of in its interior.

On examining lately a specimen of fossil wood, exhibiting the structure of

a palm, I discovered a portion which, instead of being compact like the general mass, broke down on the slightest pressure into minute fragments: on submitting these to the microscope, it was found that they were composed of cylinders more or less elongated and minute rounded granules. On the cylinders there could readily be observed a perfect screw, the helix being either single or compound, and undoubtedly fashioned from the interior of the recent spiral vessels, which fact gives the most satisfactory proof that the fibre is in the interior of the cylinder, as these siliceous casts could not have been so moulded if the spiral fibre had been external. The intervals between the helix show the shape of the fibre, and also show that it was of a solid nature.

The other point that has occasionally been the subject of controversy, is the nature of the discoid bodies on the woody tissue of coniferous plants. These have been supposed by some persons to be glands; by others to be thicker, and by others again to be thinner places in the membrane forming the walls of the woody fibres. Others have asserted that there is a pore in the centre of each disc, which allows of a communication between adjoining fibres. Later observers however have shown that none of the above theories is altogether correct, as the discs are not proper to one woody fibre, but are formed between two contiguous fibres, each contributing to the formation of the disc by having a minute depression, shaped like a saucer, on its exterior, which corresponds exactly to a similar depression on the contiguous fibre, whereby a small cavity is left between them. These markings or cavities very rarely exist on the sides of the fibres opposed to the pith or bark, but are very numerous on the sides parallel to the medullary rays. Wherever the markings occur, the saucer-shaped depression is thick at the circumference and for some distance towards the centre; but in the centre itself there is a spot so extremely thin and minute, that the light, which has to pass through it, becomes decomposed, and the spot looks either green or red, according to the adjustment of the focus.

Having received from Professor Bailey a specimen of fossil wood which was found at Fredericsberg in Virginia, I perceived, on submitting it to the microscope, that it would easily break into minute fragments in the direction of the woody fibres, which, when carefully viewed, presented a most beautiful

example of casts of woody tissue, with numerous spirals traversing the interior. At various points were arranged the ordinary coniferous dots, and to the outside there adhered small bodies of the same size, which projected beyond the outline of the fibre when seen obliquely, each bearing the precise representation of the coniferous disc. In other parts of the field of view were some of the same bodies detached from the sides of the fibres, which left no doubt that they were casts of the cavities existing in the original plant, and proved the correctness of the view above stated respecting the nature of these minute circular markings. Besides these siliceous bodies in the fragments of the fossil, there were others of such a shape as to leave no doubt that they were casts of the interspaces between the cells or woody fibres.

There is very little doubt now, from the use of chemical tests, that fossil woods for the most part, or perhaps in all cases, still possess portions of the vegetable tissues, which are cemented together into a compact mass by silica, derived from the water to which the specimen had been subjected. It is difficult to account for the lodgement of silica in the tissues of plants; but it is possible that the molecules of silica, which exist as one of their organic constituents, form the first attractive points, to which others are added by the water, until the whole of the portion of the plant, the woody fibres, the vessels and cells, and the interspaces between these organs, is filled, (in fact all places which in the recent plant are filled with sap and air,) after the manner that the spicules of silica in a sponge form nuclei for the subsequent deposits of flinty matter, until the whole is converted into a shapeless mass like the original sponge.

It follows from these observations, as every fibre, cell and spiral vessel is a closed sac or tube, that when any vegetable tissue becomes fossilized, the silica occupying their interior and their interspaces is, in fact, in detached pieces, each being separated from the adjoining cell or vessel by the intervening walls of the tissue. If fossilization went no further, and there is reason to believe that in some cases it does not, the mass could easily be broken down by slight force, and each original fibre detached from its neighbour on account of the vegetable matter, after long maceration in the silicifying fluid, being almost decomposed. But frequently the process goes further; and as we know how readily vegetable membrane transmits liquids through its sub-

stance, it can be easily imagined how silica held in solution in the water would pervade it, and the intercellular spaces and the interior of the woody fibres would be cemented together into one mass of silica.

The reason why some woods break down more easily than others after being fossilized, I have not yet been able to determine; but it is certain that coniferous woods are found to be the most frequent examples in which the tissue is not cemented, and I imagine that in those woods there is great power of resisting decomposition when immersed in water, or there exists little or no silica as an organized part of their skeleton, so that no points in the membrane for the commencement of deposits are offered; whereas, where silica does exist, the molecules form the first centres, and the whole become cemented together.

It is thus, I am induced to believe, that silicification in the above instances proceeded so far as to fill the fibres, vessels and cells, and the spaces on their exterior; but as the vegetable membrane was interposed, the complete cohesion of the parts was prevented, and consequently they are now capable of being separated, and the frustules of silica when examined prove to be casts of the interior of the tissues and of the interspaces external to them, thus appearing to offer the most satisfactory evidence respecting the nature of the organs in question.